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ERRATA.

Quarterly Journal 1930, Part IV.

Page 172 fourth para; for "*deflocculated*" read "*flocculated*".

,, 179 third para; sub-heading: for "*Aridity*" read "*Acidity*".

,, 182 fourth para; for ".....has reduced the *acidity*....." read ".....has reduced the *pH value*.....".

,, 185 second para; for ".....the effect of sulphur in reducing *acidity*....." read ".....the effect of sulphur in reducing *pH value*.....".

,, 186 second para; for ".....have reduced the *acidity*" read ".....have reduced the *pH value*".

,, 186 second para; for "there is still further reduction in *acidity*" read "there is still further reduction in *pH value*".

,, 187 second para; for "sulphate of ammonia in *decreasing* acidity" read "sulphate of ammonia in *increasing* acidity".

,, 188 Summary, seventh para; for "*reduces*" read "*increases*".

GUEST HOUSE.

Tocklai Experimental Station.

GUEST HOUSE

Tocklai Experimental Station

The Guest House at Tocklai, built by The Ellerman's Arracan Rice and Trading Co., Ltd., was completed in February 1930, has accommodation for twenty people in ten double bed rooms. It is a two-storied building of a somewhat severe type of architecture that harmonises with the general conception of an institution devoted to the study of science.

In 1922 a suggestion was made by Mr. T. McMorran that a series of lecture courses should be held at Tocklai. This suggestion was accepted by the Indian Tea Association, and since then Lecture Courses have been held annually in the cold weather. Those attending the courses had, however, to be accommodated in temporary quarters constructed of grass and bamboo which were cold and far from comfortable during wet weather. The need for some kind of permanent accommodation for those wishing to visit Tocklai had for long been felt, and it was decided that when building a Guest House it should be made not only sufficient to accommodate casual guests but should be able to accommodate all those attending the Lecture Courses. That this was a wise decision cannot be doubted for it not only allows of the cold weather series of lecture courses but also makes it possible to hold such courses at any time of the year. This is an advantage since the experimental factory is now working and a study of the manufacturing process, which can only be done during the rains when temporary housing accommodation is impracticable, is now possible.

The Guest House is comfortably furnished, but guests have to bring their own bedding and personal servants.

A charge of Rs. 20 per diem is made to meet the cost of messing, lighting, punkhas and incidentals and the cost of upkeep.

REPORT ON TEA IN THE KANGRA VALLEY, PUNJAB

By

P. H. Carpenter

The Kangra valley in the Punjab is situated at the foot of the south-western face of the Dhaula Dhar range and runs approximately in a south-easterly direction. The main entrance to the valley from the plains is by Pathankot, lying north-east of Amritsar, at a distance of approximately 138 miles. From Pathankot a metre gauge railway runs up the valley. There is also a good road running as far as Kulu on which a number of motor buses and lorries ply.

The Kangra and Kulu valleys can be considered together. Kulu is well-known for its fruit orchards, and there is very little tea grown in this part. The fruit growing does not, however, extend into Kangra owing, I was informed, to hailstorms occurring at the time of flowering of the fruit trees and causing a great loss of crop. In Kulu damaging hailstorms are infrequent. The tea growing area is in the Kangra district, and although hail does do a certain amount of damage to the tea it is not regarded as an important factor in determining the suitability of the distried for tea cultivation. The main tea growing area is now close to Palampur, a distance of 70 miles from Pathanket, although areas of tea are noticed in many places. The total area under tea is about 9,700 acres.

The cultivation of tea appears to have been commenced in earnest from about 1860 when various lands were sold for tea cultivation to individuals, mostly British Officers. The cultivation of tea appears to have been satisfactory, but as the North-East India tea estates developed the effect of competition was severely felt by the Kangra estates. This would appear to have reached a serious state during the slump in the tea market about

1900. In 1904 the big earthquake occurred in the Kangra district and from then many of the British owners and managers left the district and disposed of their estates to Indians, who in many cases appear to have remained absentee owners and to have taken but little interest in the maintenance of the tea on these estates. During my visit I saw no young tea, and it seems doubtful if any appreciable amount of tea has been planted since 1900. Most of the tea is probably considerably older. Since a tea plant like any other plant has an age limit, it is necessary to take this factor into account when considering the tea as it is to-day in Kangra. As the tea bush gets older it loses its early vigour, and it is by no means so easy to renovate old tea as young tea. Whilst the age of the tea bush may be considered as a factor affecting its present condition, it is in my opinion but a mninor factor. Other factors connected with tea cultivation play a more important part in the general debilitated conditions of tea in the Kangra district.

Jat.

The jat of tea that has been used for planting is that known as China and China hybrid. Only on more or less small experimental areas, on one or two estates, has the indigenous variety of North East India been planted. It appears to be growing equally as well as the China type.

The China variety yields a good quality tea, but has a smaller cropping capacity than the North East India variety. In North East India the use of the indigenous plant has proved to be better than the China, and this would probably be the case in Kangra also. It would, however, be advisable to use the dark-leaved variety, such as that known as Burma, rather than the light-leaved Assam.

Climate.

It was not possible to obtain any official meteorological records at Palampur, but Mr. Wilkins of the Mission at Palampur very kindly let me examine his records. In tabulating these it makes them more interesting if they are placed side by side with records of other

districts, and consequently I give also the figures for Tocklai (Assam), Darjeeling and Ranchi.

Rainfall in inches

Month	Kangra (Palampur) 1926—1927		Tocklai (Assam) Average	Darjeeling Average	Ranchi Average	Lahore
January	2·12	0·90	1·00	0·76	0·63	1·05
February	0·88	5·64	1·56	1·08	1·24	0·94
March	10·38	3·15	3·62	2·01	1·10	0·86
April	3·04	3·45	8·09	4·08	0·80	0·54
May	11·57	6·02	9·16	7·83	2·33	0·70
June	0·24	3·61	12·90	24·19	9·00	1·68
July	37·88	29·66	16·72	31·74	14·46	8·48
August	30·12	55·56	13·30	25·98	13·61	5·23
September	13·16	10·95	10·79	13·34	8·23	2·36
October	0·13	1·57	4·61	5·35	2·79	0·25
November	0·62	0·70	0·90	0·24	0·37	0·07
December	1·17	0·53	0·33	0·20	0·16	0·36
	110·31	121·74	82·98	116·80	54·72	19·52

Temperatures—Degrees Farhenheit

Month	Kangra				Tocklai		Darjeeling		Ranchi		Lahore	
	Max. 1926		Min. 1927		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January ...	60	58	40	43	70	48	47	35	74	51	68·5	41·5
February ...	63	56	43	46	73	53	48	36	77	55	72·1	45·0
March	...	72	47	56	79	60	56	42	87	64	83·3	54·6
April	73	81	57	61	83	66	62	49	96	72	95·7	64·6
May	80	80	65	65	85	72	64	53	99	76	104·9	73·7
June	90	88	73	73	90	77	65	56	92	76	107·1	80·5
July	82	81	71	65	90	78	66	65	84	73	100·6	80·7
August ...	76	82	70	68	89	78	65	57	84	73	97·7	79·3
September ...	76	92	65	68	88	76	64	55	84	72	97·9	73·8
October ...	77	78	61	67	85	71	60	50	83	66	94·5	60·8
November ...	...	69	...	69	78	60	54	42	78	58	83·2	48·4
December ...	62	63	44	53	71	50	49	37	73	51	72·3	41·1

Soil.

The soil consists generally of two types—somewhat sandy grey soil and a red clay which, under continual cultivation and without any manurial treatment, are probably low in available nitrogen and in some cases also in orginic matter.

Samples of soil collected from four tea areas showed the following acidity figures :—

Name		Hopkins acidity	pH soil solution	pH Hopkins extract.
Baijnath ...	Average Tea ...	Almost neutral ...	6·0	6·8
	Poor Tea ...	21	5·7	...
Bundla ...	Average Tea ...	Almost neutral ...	6·3	6·8
	Good Tea ...	14	6·0	6·1
Holta ...	Good tea under shade	53	5·6	5·4
	Average tea unshaded	Almost neutral ...	6·0	6·8
Sulah ...	Zemindary Poor Tea...	Almost neutral ...	6·4	6·8

Such soil acidity figures would be regarded as indicating soils unsuitable for tea in North-East India. Such soils, however, will undoubtedly support the tea bush but its rate of development and growth is slow, and on such soils the cropping capacity of the bushes is very much reduced. It requires an acid soil to produce rapid vegetative growth of the tea bush.

Manuring

Practically no manuring is done and but small quantities of cattle manure are available for this purpose. The application of oilcake is stated to give good results as does also the use of nitrate of soda and ammonium sulphate, but these manures appear to have been used only for one year and no knowledge of the effect of systematic and continuous annual applications is obtainable.

Green cropping is not done.

Shade trees are growing. No great amount of care seems to be exercised in the selection of the trees although it would seem that some years ago *Albizzia stipulata*, which grows well, had been selected and planted out. When vacancies occur now amongst the shade trees no effort is being made to establish new trees. It is evident that the tea growing under shade is in better condition as judged by the appearance of the bushes than that growing in the open and it would seem desirable that shade trees should be carefully maintained. It was, however, noticeable that the effect of the shade tree was not so marked in Kangra as in some other districts such as Dehra Dun.

Cultivation.

One deep digging, costing approximately Rs. 6-8 per acre, is given in the cold weather followed by probably two lighter forms of cultivation—one in April to produce a loose mulch on the soil to protect against drought during May and June, and a second light cultivation towards the end of the monsoon to remove jungle growth. The cultivation is, however, insufficient to keep the land clean of jungle growth and many areas become smothered in a heavy growth of grass. This is harmful to the tea bush. The cold weather cultivations are both good but a much greater effort needs to be made to keep the land clean of jungle during the remainder of the year. In tea culture the main factor of cultivation is the suppression of jungle growth rather than soil stirring. Any forms of light cultivation even hand weeding would be sufficient, provided it suppressed more than at present the jungle growth. This has been clearly demonstrated on the experimental plots at Tocklai.

Much of the tea in the Kangra district is grown on slopes which in many cases have been carefully terraced, the terraces have been well maintained and soil erosion has not taken place to the extent that might have been expected. That a greater amount has not taken place has probably been due to the heavy growth of grass that has been allowed to develop during the monsoon months. This raises an important practical consideration. If the jungle is allowed to grow, soil erosion will be prevented but the tea bushes will not grow so readily. If the soil is kept free from jungle, the tea will grow much better but soil erosion will probably be much more.

Low growing shallow rooting grasses might be allowed to grow. They should be sickled so that they do not grow more than a few inches high. This will prevent erosion but will also suppress the tea crop. To overcome the latter effect application of about 30 lbs. of soluble nitrogen must be given annually. This will induce a greater cropping capacity of the bush and probably provides the most practical compromise.

Pruning.

Bushes are pruned every year and each individual shoot is carefully cut. The light pruning costs as much as Rs. 20 per acre which is expensive as judged by the average standard of North-East India. The pruning of the bushes is, however, unsatisfactory for no effort is made to maintain bushes in an area at a uniform height nor is any attempt made to keep the pruning at the same level on individual bushes so that not only do bushes vary greatly in size in any one area, but each individual is uneven after pruning, some stems being long and some short.

There appears to be no system in vogue, but coolies are allowed to cut the bush very much as they like. Also there is no attention given to the cutting back of a bush when an accummulation of non-yielding twiggy growth has developed on the top. I saw only one case of cutting back done recently, and in this case the great improvement of the bushes was very marked but even here no attempt has been made to obtain level pruning. Growth is not so rapid as in Assam but quite a satisfactory growth of new wood could be obtained in one year. Cutting back can, therefore, be done safely and advantageously and in my opinion most of the tea that I saw will need to be so cut back before it is greatly improved. The cutting back need not be very low but sufficiently so to obtain a level bush and to remove twiggy growth. Little or no attention has been given to growing large framework bushes. Bushes are generally small and it is not understood that they should be grown so as to cover the ground. The sides have been cut away and no attempt to save and develop the growth of lateral branches is made. In general whilst the framework of the bushes is thin yet the wood seems to be sound and in a reasonably healthy condition. Tea is not left unpruned.

A definite scheme of pruning is necessary and this requires careful consideration and study. Pruning is now done during the cold weather and little growth is allowed to develop before plucking starts, as every endeavour is made to pluck a big spring crop since this makes good tea. It would be desirable to know

whether pruning could be done in May of June instead of in the cold weather so as to allow of obtaining a maximum crop during the early part of the year. This system of late pruning is practised in some tea gardens situated in districts having a dry hot May and early June. It would also be desirable to know whether tea could be advantageously left unpruned for one year the pruning being done once in two years instead of annually as at present. If this could be done the cost of pruning during two years would be much less than at present, and the thickness of the pruning wood be increased.

When carrying out top pruning it should be done so as to leave the pruned surface as level as possible. When cutting one-year old wood it would probably be desirable to leave one inch of new wood below the pruning cut on the centre or highest stem and then prune the bush horizontally to this level; so that all pruning cuts are made at approximately the same height from the ground. All very thin twiggy non-yielding shoots should be removed at the time of pruning. The process is known as cleaning and thinning out.

Plucking.

The plucking as at present practised in the Kangra district is unsatifactory, shoots are plucked from all parts of the bush, whereas a level top surface should be obtained and shoots only plucked from this top level surface. All shoots growing on the sides below this level should be allowed to remain on the bush. This allows of the bush developing a wide growth.

Before plucking commences shoots must be allowed to grow for a certain length so that after two leaves and a bud is plucked there still remains say 4 inches of new growth below the plucking mark. This provides the necessary wood for the next pruning.

After the first plucking bushes can be plucked to the small leaf (commonly called the jhannum) at the base of the new shoot. Or they can be plucked so as to leave one large new leaf above the last plucking mark. The former system appears to be the better.

In order to make the best tea, shoots consisting of two leaves and a bud must be plucked but where large crop is the most desirable object, shoots can be allowed to grow so that 3 leaves and a bud are plucked.

Single old leaves should not be plucked from the bushes as I saw being done.

Shoots on which the bud is not growing normally but is slowed in growth (such shoots are commonly called banjhi) should be plucked so as to induce development of normal shoots. Banjhi shoots do not make good tea but if they are left on the bush they cause a loss of crop.

Monthly outturn figures for two estates—lbs. of tea.

April	17,000 lbs.	22,001 lbs.
May	6,370 ,,	4,630 ,,
June	8,000 ,,	1,911 ,,
July	8,000 ,,	10,185 ,,
August	9,400 ,,	13,545 ,,
September	9,663 ,,	11,060 ,,
October (approx.) ...	4,000 ,,	

Manufacture.

is of very poor quality realising in the Amritsar market about 6 annas per lb. when Cachar green tea is selling at Rs. 1-5 per lb. and Ranchi tea at Rs. 1-3 per lb.

The liquor from an infusion of good green tea should be of a pale lemon yellow colour, whereas the liquor from an infusion of a Kangra green tea is of a dirty dull brown colour.

Much I think could be done to improve the Kangra teas first by careful attention to growing the bushes so as to ensure a growth of soft succulent shoots which should be carefully plucked. When the shoots are plucked they must be taken to the factory as quickly as possible. Leaf should be taken to the factory at least twice a day, say at noon and again in the evening.

So soon as the leaf reaches the factory it should be steamed or panned, so as to stop the action of the oxidising enzymes present within the tea leaf. The oxidising enzymes very rapidly oxidise the tannin in the plucked leaf to reddish brown coloured substances and it is the production of these bodies that causes the undesirable brown colour in the liquors of the infused leaf.

In the manufacture of green tea it is then of the utmost importance that the oxidation of the tannin shall be prevented.

In the Kangra district it appears to be customary to allow the leaf to wither slightly before is steamed or panned. Such withering is a mistake if good green tea is to be made. The custom of partially withering the fresh leaf before steaming and panning has probably arisen by reason of it giving a leaf that can be more easily rolled. Soft leaf can, however, be obtained after panning or steaming by allowing the leaf to dry to a flaccid condition either naturally or by passing it rapidly through a drying machine. It can then be rolled.

The panning or steaming process is the most important process in green tea manufacture.

If the leaf is steamed it is discharged from the steamer in a very wet condition. In large factories a considerable quantity of the water is removed by using centrifugals.

In the steaming process the leaf should remain in the steamer from 3 to 5 minutes and the pressure of the steam must be regulated to ensure that the process is properly done within this time. Too low a steam pressure will not stop oxidation sufficiently quickly and the green leaf will be coloured to some extent red. Too high a steam pressure produces a tea liquor that is not bright but is hazy.

Rolling should be for a period of half to one hour.

It is of importance that rollers should be kept spotlessly clean. This is not done in the Kangra district and I saw some rollers that were very dirty.

Drying is carried out in any suitable sized drying machine. I noticed that down draft Sirocces are in use. These are probably suitable for small factories but automatic machines are required in larger factories. The Gibson Barry or Gibson Winsland machines are used satisfactorily for drying green tea although their use has long ago been given up in black tea making.

The present system of sending the dried unsorted green tea to Amritsar for grading and polishing is probably the most satisfactory arrangement that could at the present time be adopted.

Black tea is only made in small qualities in the Kangra district and its quality is very poor indeed. The manufacture of good black tea requires a more careful technique than does green tea and I suggest that for the present it is better for attention to be concentrated on green tea. I am not therefore discussing black tea manufacture for the processes involved seem to be so little understood by the garden and factory staffs.

Market.

The transport facilities from the Kangra district are good. There are good motor roads running throughout the district which allows of motor transport being used and in addition there is now a metre gauge railway running from Jugendranagar to Pathankot where it connects with the broad gauge line to Amritsar.

Transport.

Amritsar is the tea market for North-West India and is a comparatively short distance from the Kangra district. The tea sold at Amritsar is sent to Kashmir, Afghanistan and Central Asia.

I understand that tea consumption in the Punjab Province is increasing but this is of black tea and is scarcely likely to be satisfied by the black tea at present made in Kangra. At some time it may be advisable for the Kangra gardens to turn their attention to black tea production in order to supply the local demand of the Punjab Province.

Management.

The managing staff of the tea estates in the Kangra district cannot be called satisfactory for they are ignorant of the technique of tea culture and manufacture and there appeared to be no enthusiasm to learn. Supervision of work is therefore of a very low order. Such lack of competent supervision and enthusiasm must be held to be largely accountable for the deplorable condition of the tea fields and of the quality of the finished articles.

It is true that the ignorance may be due to lack of opportunity for obtaining greater knowledge. But whilst that may be some excuse for the managing staff yet it does not alter the fact that this is one of the main causes of unsatisfactory conditions of the tea industry in the Kangra district.

An additional cause and one that must not be minimised but must be regarded as of much importance is that the tea areas are owned by persons who are not managing the estates but are living at some distance and have no knowledge and but little interest in tea culture. There are at the present time no estates owned by limited liability companies which are constituted for the express purpose of tea production. The industry would much benefit if such companies could be formed or if estates could be put under the management of competent Managing Agents.

At present a very unsatisfactory system of leasing (on short term, *e.g.*, 7 years) tea areas to contractors is in vogue. This can only be detrimental; for the lessees knowing that they hold the area for only a short term have every inducement to obtain as large a crop of tea as possible at the least possible expense and consequently practically no work is done to renovate poor tea or even to maintain tea in average condition.

The tea industry needs capital for its successful prosecution. From the time of planting the seed it will probably be about 5 years before an economic crop of tea is obtained. During this time it is necessary very carefully to tend the young plants and both pruning and cultivation is necessary and on poor soil it may be necessary to apply manure.

It is, therefore, difficult to suppose that there can be much development of areas growing tea under ryot ownership. In addition it is difficult to obtain the best manufacturing results on a very small scale.

Machinery for rolling costs usually more money than a ryot could be expected to afford, a small roller costing about Rs. 1,000/-.

Panning needs necessarily no expensive machinery nor does the drying of the tea.

It might be possible for small cultivators to maintain a co-operative factory provided their fields of tea were situated so close to the factory so as to allow of the leaf being delivered for manufacture with a few hours of plucking.

At the present time I think it would be difficult to introduce directly any great improvement and one of the first requirements towards improving the industry would seem to be a demonstration area where those interested could see the results of experiments. It would be necessary for such a station to be maintained by the Agricultural Department of the Government of the Punjab in the absence of any other suitable organisation. The tea industry does not appear to be organised under any definite association such as exists in North East India (Indian Tea Association) and in South India (The United Planters' Association).

Should it be decided to have such a station then I think its area should include old tea already growing and an area upon which new tea could be planted. It would then be possible to demonstrate the renovation of old tea and at the same time the proper methods for forming young tea bushes.

Labour.

I was given to understand that the Kangra Valley can be considered a well populated area. But tea garden Managers informed me that difficulties arose from shortage of labour available for work on the tea areas. This measure can I think be attributed to the low rate of wage that is paid and in some cases to the irregularity of payment. The

payment of labour on piece work calculated to average 1 anna to 1½ annas per hour of work and a weekly payment system should do much to help matters in this direction.

During certain times of the year I understand that the shortage of labour on the tea areas can be attributed to sowing and harvesting operations generally and for this reason it is desirable to obtain as large a crop of tea during the early months of the year when labour is more plentiful. Much could I think be done in this direction by altering the time of pruning to May or June as already suggested in a previous paragraph of this Report.

Conclusion.

At the present time the tea in the Kangra valley is in a very poor and debilitated condition but I am of opinion that it could be profitably greatly improved. It should be possible in my opinion to raise the cropping power to 400 lbs. of pucca tea per acre and it might be possible for young tea treated on modern scientific lines to be raised to a crop of nearly 600 lbs. of pucca tea per acre but I doubt whether old tea could be brought up to so high a yield. I am of opinion that the tea industry in the Kangra valley could be made profitable provided modern methods are employed.

I have to thank Rai Sahib Joy Chand Luthra who organised my tour and the Extra Assistant Director of Agriculture at Palampur who accompanied me in my visit to the tea growing areas around Palampur.

I have also to thank the firm of Messrs. Raja Singh Kalyan Singh of Amritsar for enabling me to meet many of that city who are interested in the tea trade and for the trouble they took in showing me different qualities of tea that are sold in Amritsar. This help was of very great assistance to me.

THE TEA SEED BUG

(*Poecilocoris latus Dall*)

By

E. A. Andrews

During the past season tests were made on a tea seed garden in Assam with a view to ascertaining the value of Cyanogas calcium cyanide as a treatment for the tea seed bug, and the opportunity was taken to make observations on the general aspect of the problem. The observations made so far have been of exceeding interest, in that they appear to indicate that many of the ideas at present held on the subject are probably incorrect, and that in many directions further enquiry is necessary to get at the truth of the matter. Accordingly, it is deemed advisable to draw the attention of the tea planting community to certain of the observations made. It should, however, be remembered, that the observations are of necessity incomplete, this having been the first occasion on which it has been possible to achieve any great degree of continuity in the observations on this problem; by the time many of the conclusions could be arrived at it was too late to verify them, and in some cases there was neither time nor opportunity to make the very detailed observations necessary to make really certain. This note, therefore, will be but a brief reference to the salient features of the problem, as they present themselves at present.

The first published note on the tea seed bug of any value to the planter was by Antram in Part IV of the Quarterly Journal of the Department for 1911. Therein he gave coloured illustrations of the insect sufficiently accurate to enable the planter to recognise it, and a photograph of an egg-cluster. There are few planters who cannot now recognise both with ease. He also gave a note of what was then known of the life-history of the insect, and published correspondence with Dr. Butler, then Imperial Mycologist at Pusa, which appeared to show that fungal infection of the seed is a consequence of puncture

by the tea seed bug. The deductions therein made were logical and this opinion has since been held by all connected with the production and use of the tea seed. One important feature of the observations made during the past season is that they appear to indicate that the above opinion may not be correct.

The Life History of the Insect.—The life history of the insect presents the first complication, in that, in addition to the masking of the successive broods by overlapping of the generations, it appears to be variable, there being in some cases three generations a year, and in other cases four. The eggs are laid, as stated by Antram, on the leaves of the bush. They may be laid on either the upper or lower surface by the same female. The determining factor appears to be the curvature of the leaf, for as they are generally attached somewhat nearer to the apex than the base (in the photograph given by Antram the position is typical), in a much-curled leaf, offering good shelter for the eggs, the underside of the apical portion is often above, and the upperside below. The eggs are spherical, about 2 m.m. in diameter, deposited in a cluster and when newly laid may be aptly described as resembling a cluster of small pearls. The circle of fracture, at which the seed splits when the insect emerges, may readily be seen, as described by Antram. The number of eggs in a cluster has been found to vary between 10 and 16, with 13 and 14 as perhaps the most frequent numbers. In one case which has been observed the female deposited a cluster in two sections, with 6 eggs in one and 7 in the other. On occasion eggs have been found to have been deposited on the seed capsule.

Copulation appears to take place at any time of day, and lasts for varying periods up to about two-and-a-half hours. Cases have been noticed in which copulation appeared to have taken place more than once, but this point needs verification. The male may die a day or so after copulation, or it may live for as long as a fortnight later. The first eggs are deposited 3 to 5 days later, but deposition the next day, and after 2 days, is not uncommon, while in the case of females depositing eggs so late as

October, as many as 12 days may elapse before deposition of the first cluster of eggs. The female deposits more than one cluster of eggs. The most that have been deposited by a female in captivity are three clusters, and the largest number of eggs deposited by one female has so far been 37 (in three clusters of 14, 13, and 10). As a rule, the second cluster is deposited the day after the first one, and the third some three days later. Occasionally two clusters are deposited in one day, and late in the season 3 days may elapse between the deposition of the first two clusters. Deposition appears to take place at any time of day, and also at night. The female dies within a week of depositing the last cluster of eggs, times observed having varied from 2 days to 5.

The eggs are at first pearly in appearance, and turn dark brown before hatching. During July to September they have been found to hatch in as little as four days, but they may take as long as nine. At other times a week appears to be usual, and in October 8 days. Hatching may take place at any time of day, and not all the eggs may hatch at the same time, differences of two and three days being common, in eggs in the same cluster. It frequently happens that one egg in a cluster is unfertile, occasionally more. The newly hatched insects remain quiescent for three to four hours, and then commence to feed.

The insect passes through the usual number of young stages, moulting five times, and becoming adult at the fifth moult. The time spent in each stage is variable, even among insects from the same cluster of eggs. The following are the details :—

Duration of	1st	young	stage	3	to	5	days.
,,	,, 2nd	,,	,,	3	,,	8	,,
,,	,, 3rd	,,	,,	3	,,	8	,,
,,	,, 4th	,,	,,	4	,,	9	,,
,,	,, 5th	,,	,,	6	,,	10	,,

Copulation has been observed six days after emergence, and on the average the life cycle, during the season, is found to occupy two months. Owing to overlapping and variability the

insect may be found in all stages at almost any time, but taking the peak of their development the annual cycle, in this district, is as follows. The first brood commences in May, the second in July, the third in September. The individuals of the third brood may behave in either of two ways. In one case the insects attain to the last of the young stages (that immediately preceding the adult) by the end of October, and remain in that stage until the following May, when they undergo the last moult, become adult, and give rise to the first generation. In the other case the development of the third brood is normal, and a fourth brood is produced which carries the life cycle on until May. The latter appears to be general in the case of batches which emerge in August and perhaps early September, the former in the case of those emerging later in September and early in October. A curious observation, however, is the one that when it does happen that there are four broods in the year, certain individuals of the third brood do not become adult with the rest, but remain in the last larval stage until the next season. This delayed development is a by no means uncommon occurrence among insects, and may be connected with the chance of the insect of surviving unfavourable conditions. In the field the adult insect is commonly found in the cold weather, and indeed most stages can be found throughout the year, so that there are additional complications in the life cycle which yet remain to be ascertained.

Depredations of the Insect.—The tea seed bug derives its popular name from its habit of sucking tea seed, and Antram distinctly states that they live solely on the juice of tea seed. While, however, the juice of the tea seed is preferred, they will also suck the flower-buds, and stems, and we have no difficulty in the insectary in rearing the insect on flower-buds, or even on leafy shoots. Thus, it is possible to say that the tea seed bug may attack the seed in all stages, from the very earliest. It is therefore possible that the tea seed bud may cause damage in three ways :—

1. By attack on the flower buds it many prevent the setting of seed.

2. By attacking seed in the early stages it many prevent seed from attaining maturity.

3. By attacking seed in the later stages it may, while not preventing the attainment of maturity, produce the characteristic "starred" appearance and permit of the entrance of fungi to the seed.

With regard to damage done by attack on the flower buds, we have at present little or no information beyond the knowledge that the insect can, and does, suck the buds.

In the very young stages of the seed the interior is filled with a jelly, and one thing certain is that puncture at this stage will not produce seed with "starred" cotyledons. The latter are not formed by the hardening of this jelly, but begin to grow from the germinal point, and, during growth, absorb the jelly. Thus, cotyledons may form, in seed which has been punctured, without themselves being punctured. It is only when the insect punctures directly into the body of a cotyledon that any effect will be visible, unless a fungus should get in at the puncture, when, by its growth, it may destroy both jelly and cotyledons.

This question of the entry of a fungus at the puncture is one which may best be discussed at this point. To the writer it appears that there are several ways in which a fungus might obtain entrance to a tea seed.

First, should a tea seed bug puncture the seed through a point on the capsule containing fungus mycelium, the latter might be carried into the seed mechanically.

Second, the mycelium might grew in through the orifice after the insect has left the seed.

Third, fungus spores might lodge on an exudation of sap at the spot as suggested by Dr. Butler.

Fourth, the mycelium might grow through the shell of the seed without any necessity for the intervention of the insect.

Fifth, when the seed has been removed from the capsule, attack may occur in the second manner described above from infected seed or soil in contact with it.

Sixth, infection may still occur by the fourth method, after the removal of the seed from the capsule.

With regard to the first method we have as yet no positive evidence, but it would appear to be highly probable that infection does sometimes occur in this manner, in which event prevention would consist in either destroying the insect, or killing out the fungus with a fungicide, or both.

With regard to the second and third methods of infection, it is postulated that the orifice made by the insect remains open, for at any rate a sufficient time for the mycelium to grow through, or for a chance spore to lodge, develop, and grow through. Now it has been found that after the insect has sucked the seed there is, indeed, a drop of exudate, on the surface of the capsule, at the puncture. Within a comparatively short time, however, less than 24 hours, the puncture is closed—not at the surface of the capsule, but at the shell of the seed. It has, so far, been in very few cases possible to make out the punture with certainty in the soft shell of a seed in the young stages, even though it was easily visible where it passed through the capsule. In hardened seed, with solid cotyledons, it is possible, if the seed be taken at once, to see the puncture in the shell, as a neat hole 0.06 mm. in diameter, and, corresponding with it internally, the marks of the four setae (needle-like jaws) on the surface of the hardened cotyledon. Shortly after, however, the puncture is found to be closed by growth of the layer forming the shell, and while the marks of the setae can be clearly made out in the cotyledon no puncture can be made out in the shell. Thus infection, if it does occur, must occur at once. This is, of course, not impossible, in the case of methods two and three above, but is quite out of the question in the case of methods five and six. In no case, in seed received for examination, whether "starred" or unstarred, has it been possible to make out the typical puncture of *Poecilocoris latus*. In seed which

has been much punctured indentations may be seen. And where there are many the seed coat has a roughened appearance, but all the orifices have been plugged up by growth from the inside surface of the shell. Further, there are other openings on the shell, of much greater size than that made by the tea seed bug. The first is the micropyle of the seed. In addition, there are irregular cracks, apparently produced by local stains and stresses in the shell itself when hardening, and in many cases the shell has been found to be cracked, while still in the capsule, by premature development of the seed within it. In the latter case, certainly, many instances were found of mycelium growing in at the crack, but in most cases it spread on the inside of the shell, and between the cotyledons, without attacking the latter. Many hundreds of observations were made in an attempt to correlate the presence or absence of the cracks, produced in the shell when hardening (presumably), with the presence or absence of fungus infection. No such correlation was obtained, although in some instances more than 80 per cent. of the seed showed such cracks. It must, therefore, be admitted that, so far as the evidence goes, the entrance of fungi by methods two, three, five, and six above is at any rate uncommon, and that the postulation of puncture by *Poecilocoris latus* as an exposure to the danger of subsequent infection is by no means justified, and, indeed, will demand very definite proof before it can be accepted.

With regard to the fourth method of infection a detailed mycological investigation would appear to be desirable. A large number of cases were observed in which fungus mycelium appeared to have grown from the capsule through the shell on to the cotyledons, without the intervention of any external agency. In many cases the seed had also been punctured by the tea seed bug at a point remote from the area in contact with the fungus-infected portion of the capsule, and, though starred, no fungus was to be found at that spot. To test this question, two samples of seed were divided into three portions. One portion was examined immediately. Of the other two portions, one was

stripped from the capsules and stored in an open box; the other was left in the capsules and stored in another box. Both samples, except as regards the presence of the capsules, were under identical conditions. A few seeds were examined from each of the two portions day by day for almost a month. The following were the results :—

	First sample	Second sample
Examined immediately		
Sound	97·7%	87·5%
Infected by fungus	...	2·5%
Otherwise unsound	2·3%	10·0%
Stored in the Capsules		
Sound	43·7%	50·0%
Infected by fungus	56 3%	47·3%
Otherwise unsound	...	2·7%
Stored after removal of Capsules		
Sound	90·0%	66·7%
Infected by fungus	6·7%	33·3%
Otherwise unsound	3 3%	...

There was no question of further puncture by the tea seed bug, and, while the seed removed from the capsules was freely exposed to fungus spores, the other portion was more or less protected by the enclosing capsules.

The above figures would appear to leave little doubt that this aspect of the question is important.

To sum up. There is no evidence to show that mechanical infection, which may admittedly be possible, does not take place when the tea seed bug punctures the seed, but it does not appear to be of frequent occurrence. Fungal infection as a subsequent result of puncture by the tea seed bug cannot with justification be postulated. The evidence available shows it to be highly improbable, while there is evidence that direct infection by growth of mycelium through the shell is of great importance.

To return to the question of "starring" of the seed by the tea seed bug, we have seen above that this can only occur when the body of the cotyledon is actually pierced by the insect. Thus the so-called "starred" seed is that which has been sucked at a comparatively late stage of formation. Even then, however, it is found that the familiar white "star" is not always produced. Examination of the seed, immediately after puncture, shows a more translucent area than the body of the cotyledon, extending to a greater or less distance from the point of puncture. As time goes on this usually takes on the white "starred" appearance, but it may not always do so. The appearance is connected with the formation of starch in the seed, and it is found that the time at which this begins to form in the seed varies. In some cases traces of starch in the form of definite granules, can be found at quite an early stage in the formation of the cotyledons. In other cases well-formed seed, with fully-formed cotyledons, is without a trace of starch, and there are all variations between the two. It appears probable that this controls the appearance of the damaged area, for the white appearance is found to be due to the starch, which is not taken up by the tea-seed bug. In the majority of cases, however, a well-formed star is produced.

If a drop of iodine solution be placed on the surface of the cotyledon, on the starred area, the whole area will turn deep blue immediately, but over the sound part of the cotyledon no such result is obtained. Sections prepared from such treated seeds for examination under the microscope, show, however, that the starch in the seed is by no means confined to the starred area, it being equally plentiful throughout the rest of the seed If sections be made through a starred seed before treatment with iodine, and treated with iodine on the slide, it is found that starch in cells outside the starred area is coloured blue, provided that the cell wall has been broken. Should sections of some thickness be cut, to ensure that there shall be unbroken cells in the middle, it is found that while the starch granules in the upper and lower layers of damaged cells stain with iodine those

in the middle layers of unbroken cells are unstained. If the section be allowed to dry out the starch in the middle layers will then stain. It would therefore appear that the formation of the starred appearance may be connected with the removal of moisture from the seed, and every planter knows that seed allowed to dry out shows a granular white appearance all over, very similar to the appearance of a starred area. If, however, a seed which has been allowed to dry out somewhat be put into damp sand, it will absorb water and germinate, and the cotyledons will be found to have re-assumed their normal appearance. This is not the case with starred seed, as the starred area is quite distinct and typical in seed which has been germinated. It is therefore probable that puncture by the tea seed bug has some further action on the seed, and the matter is under investigation. However that may be, it is apparent that the damage, if any, done to the seed by *Poecilocoris latus* does not extend beyond the starred area; also, that the food material stored up in the form of starch is not removed. Further, since the seed is so situated in the capsule that the germ is unlikely to be actually punctured by the insect, and damage, if any, does not extend beyond the starred area, prevention of germination by puncture by the tea seed bug, in well-formed seed, is likely to be most exceptional.

While pointing out, therefore, that further work is necessary to obtain more positive evidence, it may be intimated that the observations referred to above would appear to indicate that *Poecilocoris latus* may not be so black as he has been painted.

An experiment on Control of the Tea Seed Bug. An attempt was made during the season to ascertain the feasibility of destroying the tea seed bug by the use of Cyanogas calcium cyanide. A most suitable site for the experiment was chosen on a seed-garden, some 50 miles from Tocklai. This seed-garden is dumb-bell shaped, the bar of the dumb-bell occupying an area of about 5¼ acres, and containing 119 lines of seed trees. The prevailing winds were not quite, but almost along the length of the area, so that thorough fumigation was made

easier. Subsequent infection, moreover, could occur only by the insects filtering in from each end, so it was hoped that the centre of the area might be kept reasonably free.

The area was dusted twice—first when the cotyledons in the forward seed were mostly about one quarter formed, the actual date being July 15th., and again about a month before collection of seed commenced, the date being September 3rd.

Two types of dusting machine were used in the first experiment, a bellows machine and a rotary machine. The latter was found to be much more efficient, and this type only was used in the second experiment. The machines were fitted with a long flexible nozzle, so that the mouth of the nozzle could be raised to some 7 feet from the ground. The method of dusting was to commence at the foot of the tree, and move the nozzle gradually up until the tree had been thoroughly dusted. The men were placed in line across the wind, and moved back in line into the wind. Some of the trees were too high for the tops to be dusted efficiently, but it was found that, as the breeze carried the dust gently along, it also carried upwards, so that eventually the high tops were enveloped in the dust, and the whole area was enveloped in a uniform fog caused by the dust. The fumigation of the area was apparently complete, and for some hours later the area was unpleasant to walk through.

It must be admitted that the action of the dust, on the insect in the field, was erratic. Some of the insects were killed, but others appeared to survive.

Some idea of the value of the first dusting may be gathered from the table given on page 22 above, in which the first sample of seed was taken from the untreated area, and the second sample from the middle of the treated area. The result was not encouraging, but samples were taken during the collecting season from four areas.

Area I was near one end of the treated area.
,, II was at the centre of the treated area.
,, III was near the other end of the treated area.
,, IV was in the untreated area, taken from a spot away from the direction taken by the breeze.

All samples were kept separate in collecting, taken to Tocklai, and put through the thorough test to which all samples of seed intended for export have been submitted. No selection of seed was of course made. It was bulked, and representative samples put through the examination as pressure of work allowed, on each occasion one sample from each plot being put through. The following table gives the percentage results of the examination :—

	Area I	Area II	Area III	Area IV
Sinkers	77·7	81·6	72·3	78·9
Floaters	22·3	18·4	27·7	21·1
Sound	49·4	55·6	31·0	45·3
Starred	7·5	8·6	9·6	12·2
Infested by fungi ...	33·2	31·7	51·9	33·9
Otherwise unsound ...	9·9	4·1	7·5	8·6

It will be observed that while results in other directions are irregular, there has been a distinct decrease in the percentage of seed starred by the tea-seed bug, the decrease being 3.6 per cent. During the experiment it was found that the amount of Cyanogas used to give a satisfactory dusting was two-thirds of an ounce per bush, which, on the particular area treated with Cyanogas at Rs. 1-8 per lb. in Calcutta, works out at Rs. 28-2 per acre per dusting for material. Freight, depreciation of machines, and labour must be added to this. Two dustings, costing Rs. 55-4 for material alone, produced a drop in starred seed of 3.6 per cent. Assuming that it were all profit, and that Rs. 1,000-0 per acre be an average yield from a seed-garden, the yield would be Rs. 36-0 per acre.

It should be remembered that a decrease of 3.6 per cent., on the whole crop, is a decrease of over 30 per cent. in punctured seed, so that the Cyanogas would appear to have killed an appreciable percentage of the tea-seed bugs in the area, but the damage due to tea seed bug is small compared with that due to fungi, and in view of the observations recorded above it would seem that the latter is the more important aspect of the problem.

Other aspects of the problem were touched on during the investigation. The possibility of tea eelworm getting into the seed on the tree was suggested, and this, if it be so, will revolutionise ideas in that direction; a new insect pest of tea seed, a Muscid fly, came to light, but only one specimen was obtained, so that it may be of little importance; thanks to the courtesy of the manager of Kalline Tea Seed garden, we were able to obtain an Ichneumonid egg parasite of the tea seed bug. Further investigation on all these is necessary before any conclusions can be stated, but it cannot but be admitted that the observations made during the past season, incomplete as they be shed considerable light on the complexities of the problem of the tea seed bug.

For the opportunity of making these observations, the writer has to express his great indebtedness to Mr. A. D. Jones, of Nahorjan T. E., and to Mrs. Jones, whose unstinted and long suffering hospitality proved more than equal to the considerable strain which must have been imposed upon it. The unkindness of the elements put considerable difficulty in the way of carrying out the experiment, which difficulties were ably surmounted by the interest and energy of Mr. Jones, and of his assistant Mr. Boyd. Messrs. Shaw Wallace and Co., of Calcutta, treated us most generously in the matter of material and machines, and extended most courteous assistance in the provision of rotary machines for the second dusting.

VEGETABLE PARASITES OF THE TEA PLANT

(*continued*)

By

A. C. Tunstall

BLIGHTS ON THE ROOT

Fomes lamaoensis, Murr.,—*Hymenochaete noxia*—Brown root rot.

Refs. :—Watt and Mann, " The Pests and Blights of the Tea Plant", 2nd ed., p. 411.
Butler, " Fungi and Disease in Plants", pp. 429, 480 and 506.
Petch, " Diseases of the Tea Bush", p. 159.
Circulars and Agricultural Journal of the Royal Botanic Garden, Ceylon, Vol. V, No. 11., digest of which was reprinted in the Quarterly Journals of the Indian Tea Association, 1912, Pt. 1, p. 18.
Indian Tea Association, Pamphlet I, " Tea Roots", Pt. II, 1918.
Indian Tea Association, " Quarterly Journal", Pt. IV, 1923, p. 133.
Petch, Tea Research Inst., of Ceylon, "Tea Quarterly", Vol. I, Pt. I, p. 10, 1928.
Found in all the tea districts of India.

History :—Watt and Mann included this disease under the general name of " Stump Rot " and associated it with *Rosellinia Sp.* It was recorded by Cunningham in 1887, and further examined by Massee in 1897. It was recorded from Java in 1904 and from Ceylon in 1905. It was found in Samoa on bread fruit trees in 1875.

The fungus was identified by its vegetative structure, as no mature fructification of the fungus was detected on tea. It was

originally named *Hymenochaete noxia*. But subsequently Petch found the fructification of the fungus on tea in Ceylon, when it was renamed *Fomes lamaoensis*. So far no mature fructification of the Brown root rot fungus has been observed on tea in India. As it has been found on jungle tree roots in the vicinity of diseased tea roots and it resembles the Ceylon fungus so closely in other respects the Indian fungus is probably identical.

It has been recorded from Japan, F.M.S., Burma, West Africa, Dutch E Indies, Philippine Islands on Rubber, Coffee, Cacao, Camphor, Cocoanut, Teak, *Dalbergia Sp.*, Sal, Siris, Gold mohur, Simul, Rahar, Boga medeloa and many other plants.

Description :—As a general rule the first intimation of an attack of this disease is the sudden death of two or three bushes adjoining one another. Sometimes as many as twenty will die out within a week. The most characteristic feature of this fungus is the presence of a crust of earth and sand on the diseased roots. This crust is held together by a felt of brown mycelium, which later changes to black. This crust may extend up to the stem above ground level for several inches. This may have taken many days to develop. If the bark of the root be removed there may be seen a thin layer of white or brownish mycelium between it and the wood. Unless the disease is in its early stage the wood will be seen to be marked with thin russet-brown lines which anastomose frequently. The wood may not exhibit much evidence of decay in the early stages but in old cases the tissues within these dark lines decay leaving a honeycomb structure, the bounding lines being dark and hard while the intervening rotting portion is yellow and soft. The fungus first of all attacks the bark cells and spreads from these to the wood and pith.

The fungus rarely fruits in North East India. The writer has found only three specimens of the fruit body (immature) on tea so far. The fructification is a brown plate of mycelium adhering to the collar just above the soil. Another immature fruit body formed on a piece of gunny bag in which a diseased bush had been packed. Mature fruits of this fungus have been found on

decaying logs in contact with tea bushes which have died of Brown root rot and the appearance of the fungus in the decaying jungle wood was identical. Petch describes the fructification of this fungus in the following terms.

"It is bracket-shaped, often irregular and consisting of several brackets fused together side by side, three or four inches broad, about half an inch thick, and very hard. On the lateral roots of mango and Hevea it may form a continuous border, running for several feet, on either side of the root, united by a resupinate part on the lower surface. The developing pileus is purple-brown, or almost black, with a yellow margin. When mature and dry, it is purple-brown to blackish-brown, often with concentric, narrow, blackish zones, sometimes yellow-brown towards the margin, smooth, and sometimes concentrically furrowed. The lower surface is dark brown, or almost black, often with greyish bloom. When broken in two, it is seen to consist of a thin, dark, hard outer crust, with brown, or yellow-brown, tissue internally, the latter usually zoned with curved lines parallel to the margin. The lower half of the section consists of a darker layer of vertical tubes in which the spores are produced."

As the fructification is so rare spores play little part in infection and their agency may be ignored. In most cases the infection can be traced along a root to a decaying tree stump. Fence posts, bridges, in fact any kind of dead wood, may form a centre of infection. The fungus does not spread through the soil, nor does it appear to live in the soil apart from dead wood. On dead wood it may live for very many years and any tea roots growing in contact with the diseased wood become infected. For instance, at Tocklai an outbreak of this disease on five year old tea was traced to a piece of Nahor (*Mesua ferrea*) root which must have been buried in the soil four feet deep for at least fourteen years. Similar observations have been recorded from Ceylon also.

This fungus has been successfully grown in pure culture in the Tocklai laboratory, but has never produced any fructifications.

Repeated attempts have been made by us to inoculate living roots with mycelium obtained from pure cultures but they were all unsuccessful.

It was only possible to obtain successful inoculations by tying pieces of dead wood previously inoculated with the mycelium of the fungus to the roots and then covering them up with soil. Out of five bushes inoculated in this manner in the field after fifteen months one was killed by the fungus, but the remaining bushes did not show any distinct sign of infection even after two years.

Depredations :—The disease is always more prevalent on sandy soils which have recently been opened out from virgin forest. The older forests of Assam wherever they are growing on sandy soil are badly infected. The death of a few bushes is usually a forerunner of many deaths at the same place. Ring after ring of plants die out and if the disease is not checked acres of tea may be destroyed in a few years. In some cases the writer has seen as much as twenty acres of tea killed out in one patch. Fortunately the disease does not spread very rapidly from bush to bush; but as it generally takes some months for an infected bush to die, a considerable number of plants in the neighbourhood of the dead bush may be infected and be spreading infection for a long time before the presence of the disease is suspected. The disease usually atttacks well-grown bushes, but there are instances of young plants also being attacked. In one case thousands of plants died in one year on a young clearance.

Treatment :—The best way to deal with root disease of this kind is to dig out the dead bushes, carefully tracing the diseased roots. As a rule all the roots of a dead bush are not equally attacked. The badly attacked ones should be given special attention, as it is frequently possible to trace them to the centre of infection. This is often a piece of a jungle tree. This should be removed. At the same time all the immediate neighbours of the dead bush should be dug out. Some of them will probably be infected, so the roots of these should also be examined and the immediate neighbours of any of these bushes found diseased

should be removed also. In carrying out these operations special care should be taken to remove all the wood from the soil. This should all be burned. The above procedure sounds very complicated, but it is actually very simple and much more effective than surrounding the dead bushes by a trench.

Fomes Applanatus, Pers

Ganoderma Applanatum

Refs. :—Petch, " Diseases of the Tea Bush", p. 167.

History :—Although this disease is very common it is rarely found on tea in North East India. Only one instance has so far been observed. In 1924 a specimen was received from the Darrang district.

It was found on tea in Ceylon in 1918. It has been found on *Melia* in South Africa, on *Acacia decurrens*, Cocoanuts, *Inga saman* (*Pithecolobium saman*), *Grevillea* in Ceylon and on Coffee, Cacao in St. Thomas Island and various other trees in other countries. It is known to cause root disease of Coffee in South Africa.

Description :—As only one specimen has been found in North East India, the following description is quoted from Petch.

" There is no external mycelium evident on the diseased roots. The bark is blackened, and sometimes the roots bear small holes, up to three millimeters in diameter, which extend through the bark and appear white at the base. When the bark is removed, small scattered patches of brownish-white mycelium are found between the bark and the wood ; these usually adhere to the bark, and give it a mottled appearance on the innerside. When the root is split open, the wood has a mottled appearance, being minutely flecked with brown and white. These flecks are very small, and they are not arranged in a honeycomb fashion as in Brown root disease. Any wood which has been exposed in the soil is blackened with pockets of black or dark brown wood extending inwards.

The fructification of the fungus is produced on the main stem, generally well above ground-level, about the point where it divides into the main branches. It is of the usual bracket shape, and from three to twelve inches in diameter. When extending outwards horizontally from the stem it is generally small, but it may form a mass up to a foot in diameter and several inches thick in the middle of the bush. Its upper surface is zoned, grey and brown, and has a very hard outer crust, but it is dull, and polished. The under surface is white. Internally it is dark brown, fibrous above, and with a thick layer of tubes below. When it produces spores, these are frequently deposited on the upper surface in a bright brown powder, as in the case of *Fomes lucidus*.

Fomes applanatus is one of the commonest bracket fungi on decaying stumps in the tropics, and is easily identified by its colour and its hard outer crust. But it is comparatively rarely found to attack living trees, and can therefore only be regarded as a weak parasite."

Depredations :—It does not cause any appreciable damage to tea in North East India.

Treatment :—Same as in the case of *Fomes lamaoensis*.

Fomes lucidus (Leys) Fr.

Ganoderma lucidum. (Leys) Karst.

Refs.:—Petch, "Diseases of the Tea Bush", p. 165.

Indian Tea Assiciation, "Quarterly Journal", Pt. II, pp. 54-55, 1913.

History :—It was first observed on tea in the Sibsagar district in North East India in 1913, growing on the stumps of a number of tea bushes which died in the manner characteristic of root disease. An examination of the plants showed that one of them bore young fruit bodies of *Ustulina zonata*. This led to the supposition that *Fomes lucidus* was secondary following on death caused by *Ustulina zonata*. Later specimens, however,

showed that *Fomes lucidus* was itself the cause of death of other tea bushes. In India it is found to be parasitic on *Casuarina*, Mulberry, *Dalbergia Sissoo, Acacia arabica, Cedrela toona, Guazuma tomentosa* and *Areca catechu*. In Ceylon it is known to cause root disease of rubber, *Poinciana regia*, Mango, *Casuarina, Limonia alata, Albizzia moluccana, Oreodeoxa*, the Coconut palm and Bamboos. It is frequently common on decaying stumps of felled *Albizzias* but has not been observed to attack the tea round such stumps. It is common in Java, Uganda, North Burma, New Guinea, Dutch E Indies and the Gold coast on rubber and other plants.

In the Portuguese Congo it was found on oil palm and was considered to be closely related to *Ganoderma applanatum*, if not actually another form of the same species.

Description :—The fungus mycelium is obvious, both externally and internally. The wood attacked by the disease becomes darker in colour and contains cavities filled with white mycelium while the outside of the root is covered by tough thick cords or bands. The fructification of this fungus is very commonly found on dead jungle trees.

The fructification is generally bracket shaped, but sometimes possesses a short lateral stalk. The upper surface of the bracket is smooth and varies in colour from yellowish red to deep red. It is marked by concentric furrows. In its immature stages the edges of the bracket or cap are swollen and white. The colour of the margin gradually deepens until it assumes the same shade as the rest of the upper surface. The underside is white and made up of the open ends of myriads of minute tubes which are characteristic of the polyporeae, the family to which this fungus belongs. The sporophore varies in size from a diameter of 2 or 3 inches and thickness of half an inch to a diameter of as much as two feet and a thickness of three or four inches.

Depredations :—The disease is not common on tea, although it is frequently found on jungle trees in the vicinity of tea plants. It is probable that the fungus is unable to attack vigorous plants.

Treatment :—Remove all dead bushes, taking great care that no wood be left in the soil.

Fomes lignosus, Klotzsch.

Fomes semitosus Auctt, non Berk.

=*Polyporus microporus* of W. Indies.

=*Rigidoporus microporus* on tea and rubber in Java.

Refs. :—Petch, "Diseases of the Tea Bush", p. 162.

History :—This is a common root disease of rubber in Ceylon, Sumatra, Java, North Borneo, F.M.S., Dutch E Indies, Uganda and other rubber growing countries. It occasionally attacks tea and other plants. It is known to occur on tea in Ceylon, Java, Dutch E Indies. Its occurrence is somewhat rare. A few cases of this disease have been observed on tea in North East India. It is kuown to be a cause of disease of Cacao, *Pogostemon, Poinciana, Albizzia,* Gutta bean and Coconuts in the Gold coast, Singapore, New Guinea, F.M.S., and Ceylon. Besides these Jak (*Artocarpus integrifolia*), Ficus Spp., *Bombax malabaricum*, Ceara (*Manihot Glaziovii*), *Afzelia palembanica,* Halmilla (*Berrya Ammonilla*), *Derris dalbergioides, Shorea* sp., *Livistonia cochinchinensis* are also liable to be attacked by this fungus.

Description :—The fungus first starts on jungle stumps, whence it passes by means of thick, whitish rhizomorphic strands through the soil to the living roots of the neighbouring tea. The diseased roots are covered with stout, white or yellowish, rather flat, tough cords or strands of mycelium which run more or less longitudinally and anastomose with one another to form a network. When fresh these may have a reddish tinge, which usually fades on drying.

The fructifications usually develop on the stems at about the soil level in the form of horizontal brackets either singly or several occurring one above the other. These brackets are almost semicircular in shape, two to three inches in diameter and up to

half inch thick. Sometimes they become bigger in size. They are red brown with concentric dark brown lines.

The following description of the fructification is quoted from Petch. "The upper surface is not smooth, as a rule, but bears numerous grooves parallel to the other edge; it is these grooves which retain the red brown colour when the fungus is dry. Fine radiating striae run at right angles to the edge, and give the surface a silky appearance. The lower surface is studded with minute holes, which are the openings of the tubes in which the spores are produced; these holes are very small, and scarcely distinguishable without a lens.

The substance of the fructification is somewhat woody, but it breaks easily. The interior consists of two layers which differ from one another in colour and structure. The upper layer is white and fibrous, the fibres running more or less parallel to the surface, while the lower layer is red-brown and composed of closely packed tubes perpendicular to the lower surface."

Depredations :—The disease prefers alkaline soil and is more prevalent on loose sandy soil. It is very susceptible to acid conditions. As the tea soils of North East India are mostly acid, the disease is not of frequent occurrence. The progress of attack is very slow and it takes a long time for a bush to die. The disease does not cause any appreciable damage.

Remedies :—The affected areas should be isolated by means of trenches. The trench should be dug so as to enclose two complete lines of apparently healthy bushes. The dead bush should be dug out and the same procedure followed as in the case of *Fomes lamaoensis*.

THE CACHAR FLOODS IN 1929

By

C. R. Harler

The extent of the floods.

Throughout Assam the rainfall was far in excess of normal during the first half of the year 1929. Floods occurred in the Surma valley in May and again in June, the latter being the most serious on record. The rainfall at Cherrapunji, Silchar and Srimangal during May and June 1929, compared with the normal precipitation, indicates the nature of the excess in the Surma valley.

Rainfall in the Surma Valley

	May 1929	May average	June 1929	June average
	ins.	ins.	ins.	ins.
Cherrapunji	87·90	46·28	105·88	95·92
Silchar	43·27	15·59	35·58	21·68
Srimangal	24·93	14·96	31·49	17.05

The immediate cause of the rainfall bringing the June floods was a storm which formed in front of the Monsoon in the Bay of Bengal and moved in a north-north-easterly direction, crossing the coast between Cox's Bazaar and Chittagong during the early morning of the 4th. June. The precipitation at Chittagong on this day was 14.90 inches, followed by falls of 2 to 4 inches on each the seven succeeding days. This storm was responsible for heavy rain on the 5th., 6th. and 7th. June at Cherrapunji, and on the mornings of the 5th. and 6th. at Silchar. At the same time Imphal and the valley of Manipur received abnormal rain and the country there was flooded, with the result that the Barak rose abnormally and influenced the subsequent flooding in Cachar.

Although the storm broke over Assam during the 4th. June, it left the weather unsettled in the province for some days. Between the 8th. and 10th. another pulse of disturbed weather

passed into Assam from the head of the Bay and under the joint influence of these conditions heavy rain fell at Cherrapunji from the morning of the 8th, to the morning of the 14th., at Silchar from the morning of the 8th. to the morning of the 12th. and at Srimangal during the 9th. and the 11th. These falls caused the the floods.*

The topography of the Surma valley all points to the possibility of flooding by the rivers which drain it. The main river, rising in Manipur, is the Barak, known in Sylhet as the Surma and in Bengal as the Megna, which runs into the Padma at Chandpur. The enormous precipitation on the bare southern edge of the Shillong plateau, on which Cherrapunji stands, quickly finds its way to the Surma, and it is common for the big River to be so full on this account that it backs up, and tributaries entering higher up the course have no immediate outlet for their waters.

The North Cachar and Lushai Hills which, with the Shillong plateau, form what is known as the Surma valley, bring numerous tributaries to the Barak or Surma. Normally, rainfall in the Lushai and North Cachar Hills is held up by forests and doled out gradually to the rivers, but the excessive downpours experienced about the 9th. to 12th. June were sufficient to wash away whole hillsides and to fill valleys. No rainfall figures are available for the hills themselves, but at Sultanicherra, at the head of the Hailakandi valley, 28 inches of rain were registered in 36 hours on the 10th. and 11th. June, whilst at places in the middle of this valley about 20 inches fell on these two days. In Chatla Bheel about 16 inches were precipitated during this period.

From the North Cachar Hills the Jatinga, Dalu and Madhura enter the Barak, but since most of the tea gardens in this area are planted on banks and *teelas,* well above the water level, little flooding of the tea was experienced, exept on flats of gardens near the Barak. These were in some cases seriously flooded although no silt deposits were made.

*I am indebted to the Meteorologist, Alipore, Calcutta, for these details.

To the south of the Barak the country consists of a number of long narrow valleys formed by lines of low *teelas* jutting from the Lushai Hills at almost regular intervals. The rivers flowing in from the tea districts on the south bank include the Sonai, Ghagra, Khatakhal, Singia, Longai, Juri, Manu and Kowai. The Sonai and the Khatkhal are the only long rivers.

Most of the these rivers run into *bheels* situated near the mouths of the valleys. The Sonai runs direct into the Barak, but the Chatla *bheel* takes most of the rivers in this district. In the Hailakandi valley there is no definite *bheel,* but the Khatkhal and Dhaleswari run into a low lying area, subject to flooding, before the Barak is joined. The Singia river of the Chargola valley empties into the Son *bheel.* Haka Laki *hoar* and Hail *hoar* take some of the Sylhet rivers before they reach the Surma.

These *bheels* or *hoars* act as reservoirs for the water flowing either to or from the Barak. Thus, in times of flood the big River often flows back into the *bheel,* usually as a muddy stream depositing silt, until such time as the main stream has fallen, when the normal outward flow is resumed. At times the *bheels* are so full that the smaller rivers back up. During the June floods, however, the water level in the valleys was so high that the rivers ran at a terrific pace as did also the Barak.

Most of the flooding of tea areas took place in Chatla Bheel and Hailakandi, and in the latter district silt deposits added to the devastation. In Hailakandi it is estimated that about 3,400 acres of tea were flooded for periods ranging from 9 to 14 days. In the Chatla Bheel district the flooding was less severe and about 3,000 acres were flooded for 5 to 9 days. In the Chargola and Longai valleys only small areas were flooded. Other parts of Sylhet experienced no unusual flooding.

The flood in Hailakandi and Chatla Bheel.

Hailakandi, one of the narrowest valleys in south Cachar and Sylhet, is drained by a considerable river, the Khatakhal which rises near Lungleh, about 140 miles south of its confluence with the Barak. The gardens in the direct track of the Kahtakhal flood

were most damaged, largely by reason of silt deposits. Many areas removed from the main flood were inundated by the backing up of the small local streams and, in addition, sometimes suffered from landslip.

Sultanicherra, the most southern garden in the valley, is about 40 miles from the Barak. The Jamira flat of this garden, situated on the bank of the Khatakhal, received the full force of the flood which, receiving some check, completely covered the bushes with a layer of silt. The narrow valleys or *thals* which constitute much of the areas under tea at Sultanicherra were, as a rule, not silted but flooded by reason of the backing up of their individual streams. Serious landslips occurred in many places. In a similar manner, the various valleys which make up Kukicherra, on the opposite bank from Sultanicherra, were also flooded and suffered from landslips.

About two miles below Sultanicherra a spacious flat, on which Manipur garden stands, begins and here the Khatakhal flowed over its banks with a great force which spent itself in the vicinity of Manipur where deep silt deposits were laid. In some places the deposit was 4 feet deep. At Dholai, almost opposite Manipur, although flooding was extensive, only a small acreage was badly silted, for the main flood in this area seemed to have moved away from the left bank.

Below Dholai the normal river course swings to the west and runs along the foot of the Rath *teela*, a range of hills rising to about 520 feet, leaving a broad flat on the right bank across which was now the trend of the main flow. The lower flats of Rupacherra took the main flood, serious silting and flooding resulting. Katlicherra, on the opposite bank, sheltered by the deflecting action of the Rath *teela* range, had practically no deposit, although, in common with other gardens, large areas were flooded. Appin, still further out of the main flood and on slightly higher ground, was practically untouched.

Vernerpore was flooded and silted up both from the Khatakhal and the Lallacherra, which backed up badly. Lallacherra

garden was also flooded from the Lalla river, which only left a slight deposit. On account of its distance from the Khatakhal and its elevation Lallacherra garden was not flooded by that river.

Lallamukh is protected from the backing up of the Khatakhal by a flap-valve gate at the point where its main drainage outlet enters the river. This gate held, and flooding came from the garden streams which backed up, but practically no silt was deposited. Jafferband also has a lock gate, surmounted by a 14 ft. bank which gave way, and a rush of silt laden water flowed into the garden where, at a narrow neck between two *teelas,* it was slowed up sufficiently rapidly to deposit a very deep layer of silt, burying the tea.

Kalacherra was inundated from one angle by a silty flood direct from Khatakhal and from another by fairly clear water. At Kalacherra the Khatakhal makes a right-angled turn away from the garden, towards the centre of the valley, and then beats north again after having run in a westerly direction for about three miles. The rice land in this angle took most of the deposit and, as mentioned above, allowed a clear flood to enter the north part of Kalacherra.

Bundukmara, Mohunpore and Barni Braes were also flooded although not so seriously as the gardens higher up the valley, the full force of the flood having spent itself by this time.

Below Appin on the west of the valley the flood water came from the Dhaleswari. The Koya *bheel* was full and quietly backed up into Koya and part of Singala. At Aenakhal, the Dhaleswari is kept from backing up into the garden by an embankment which gave way. The result was that part of the water flowed into the garden, joined up with the main outlet through Kunchenpore, and widely flooded both gardens.

The gardens lower down on the western side were not seriously flooded, for the valley here has broadened considerably.

After the flood subsided the whole country reeked of rotting vegetation. The smell resembled that of retting jute or freshly

turned *bheel* soil and is typical of the smell of vegetation decomposing under water, in the absence of air. Putrefying carcases added to the general stench.

As a result of the flood much of the countryside has been changed. The *bheels* which have been slowly silting up year by year have this season been raised in many places several feet. The Khatakhal itself is wider and shallower than before and in many places at sharp bends the course has straightened with the formation of "cut offs". The banks of the river are always higher than the floor of the valley and the 1929 floods appear to have raised them several feet even above their old level.

The tendency in the future will be towards more serious flooding in Hailakandi than at present, since the capacity of the *bheels* is annually being reduced and the inevitable deforestation of the Lushai Hills must, as time goes on, release the rain water at a much faster rate than at present.

In the Chatla Bheel district the flood resulted largely from local water which was unable to get away. The Barak, soon after it enters the plains runs in a westerly direction towards Silchar, winding considerably in finding its fall and producing, in so doing, *bheel* country and forming the great loop which it makes south of Cossipore. When the flood water came, this flat country, including the area round Silchar itself, was inundated and the general movement of water was across country in a belt six miles or more wide. Silcoorie and Bhorakhai came within this belt and their low lying areas suffered. Most of the silt had been dropped before these gardens were reached and no serious deposits were made.

The Chatla *bheel* was full and the Ghagra River was unable to empty it on account of the height of the Barak. Chincoorie, Kuttal and their out-gardens were flooded from the Ghagra which also backed up into Chungdowa, the out-garden of Ratanpur, and actually topped the water shed of that garden, thus joining, for the time being, the Chatla and Tapang *bheels*. The Burni Braes

stream, leading into the Tapang *bheel*, backed up and flooded Shahpore, the out-garden of Rosekandy.

The Balichara, which drains the main valley in the Chatla Bheel district backed up as the *bheel* flooded, and inundated parts of Rosekandy, Jalinga, Allenpore and Noaband. The floods here, as in other places, were aggravated by the spate of the local streams.

Bagh-o-Bahar had a small area flooded for a short time by water from the Khatakhal which reached the garden through Kalacherra, from the Hailakandi valley.

The eastern part of the Chatla Bheel district and the Lakhipur gardens south of the Barak were flooded largely from the water of the Sonai. This is a fairly big river, the only one in south Cachar comparable in size and length to the Khatakhal. The direct distance from its source, near Aijal, to its confluence with the Barak is about 90 miles. Like the Khatakhal, the Sonai came down heavily charged with silt. Monierkhal, situated in some respects similarly to Sultanicherra, was badly flooded and silted. Bhubandhar and Rukni, far from the main flood, were only slightly silted, although considerable areas were flooded. After passing Monierkhal the Sonai took a flood course to the north, in addition to its normal course, silting the low lying country in that direction and inundating parts of Chingoor, Didarkhush, Bhuban Valley and Binnakandy. Most of the Sonai silt deposit was, however, left on the rice lands in the plain south of the Bank. At Narsingpur the Sonai is joined by the Rukni river which backed up and helped to flood Derby and parts of Banskhal, an out garden of Poloi.

The effect of flooding on the tea bush.

Apart from the harm arising from water-logging, prolonged flooding has a very definite effect on the frame and foliage of the tea bush. Tea which is flooded for a day or so, as regularly happens on parts of many Cachar gardens, does not apparently suffer much and may not even be thrown out of the plucking round. Flooding for two or three days often causes the flush to droop and

sometimes die, although this depends to a great extent on the intensity of the sunshine during flooding and whilst the water is subsiding. The reflection of the sun from the water evidently plays an important part in causing die-back of the flush.

The consensus of opinion amongst planters who have had experience with flooded tea is that bushes which have been submerged for about five days lose all their leaves. The exact length of time of flooding necessary for this to take place varies with the health of the bush. In one instance, it was obsereved that a plot of tea was flooded for exactly five days. When the water receded, the leaves, brown and dull, were still on the bush but in a day or two they were shed. It is believed that the depth of the water and the amount of sediment both influence the liability to leaf fall and it has been noticed that as these two factors increase so does the liability to defoliation.

After flooding for five days or more the one year wood starts to die back. Hence cut-back tea suffers badly, for it often dies right back to the heavy cut. In cases where the flood persists, the two year wood sometimes dies but this is often accompanied by the death of the whole branch or the bush. After flooding, the two year wood puts out shoots first and on this account unpruned tea is yielding again before other tea. The older wood shoots according to its degree of vigour.

In many cases the bushes, after flooding, put out a great number of small shoots, some of which quickly develop and then die back. A parallel to this is often seen when a young tree trunk or branch is used for a bridge or building. The dismembered log, which is not necessarily standing in soil, may throw out vigorous new leaves, nourished on the plant reserves in the wood. When these are used up, the new leaves wilt and die. Bushes which have been flooded and still have their roots in a water-logged soil are in a temporarily similar condition to dismembered frames, and the early flush, unless soon nourished by food supplies from the soil, must die back as soon as the food from the frame of the bush runs short.

After the flood subsides, the soil is often water-logged for some time and this has a very definite bad effect on the bush. In this respect the Cachar floods in 1929 were particularly harmful, coming as they did with the Monsoon ahead, the result being that the silted areas were water-logged for practically the whole season.

The silt deposits in Cachar.

The effect of deep deposits on the bush may now be considered. In many cases a deposit of a foot or more of silt has been laid in the Hailakandi valley and, although this deposit is certainly fertile for rice, yet so far as tea is concerned it is harmful if more than a few inches deep. The harm comes from both physical and chemical causes.

The feeding roots of the bush are, of course, all below the original soil surface. After the deposit of silt, the tendency will be for the bacterial life in the soil to move to the top nine inches or so of the new soil, leaving the original soil depleted of bacterial flora. Soluble nitrogen going to the plant roots must thus be prepared by the bacteria in the new top soil and then washed down to the original soil. This is not the natural method and proves to be unsatisfactory. It is possible for the wood tissue of the buried trunk to develope root tissue and to feed in the newly formed top soil. Although cases of such root development can be seen at the foot of most *teela* slopes where there is soil wash, these represent the gradual development of root from stem tissue as a result of equally gradual silting. The case of a bush silted up overnight is a different one and, in practically all cases, bushes have died when the deposit is deeper than about six inches.

The thickness of the deposit made during the Cachar floods varied from a fraction of an inch to several feet. At Kurichenpore, in Hailakandi, where the flood had to a great extent spent itself and dropped much of its deposit, observations in flooded buildings showed that a foot of water deposited silt of a thickness of 3/16 of an inch when dry. At Monierkhal, on the Sonai,

in one place 5 feet of water deposited silt to a depth of 6 inches when dry. At Kunchenpore the ratio of sediment to water was about 1 to 32 and at Monierkhal 1 to 5, taking the density of the silt as 2.

The Khatakhal in full flood carried along particles as large as coarse sand and would have moved large stones had they been present, such was the velocity of the water. Any considerable check in the current brought about the deposition of the coarser particles and only silt and clay were carried on. Thus, near the river itself, where the water overflowed the banks with a rush and then steadied up, coarse deposits were obtained. At Lallamukh one such deposit contained 87% fine sand, 6% fine silt, and only 1.6% clay.

In order to obtain a clear conception of the force of water required to move soil particles, the following table is of assistance :—

Rate of water-flow				*Particles moved*
3	ins. per sec. or	0.17	miles per hour ...	Clay
6	,, ,, ,,	0.34	,, ,, ,, ...	Fine sand.
8	,, ,, ,,	0.46	,, ,, ,, ...	Sand as coarse as hay seed.
12	,, ,, ,,	0.68	,, ,, ,, ...	Fine gravel.
24	,, ,, ,,	1.36	,, ,, ,, ...	Pebbles 1″ diameter.
36	,, ,, ,,	2.05	,, ,, ,, ...	Small stones.

The fact that coarse sand was rarely deposited away from the immediate vicinity of the river points to the quiet manner in which the water rose in most places.

The mechanical constitution of the tea garden deposits shows considerable variation. They are all practically devoid of coarse sand and in most cases there is only a small percentage of fine sand. Silt and fine silt make up about 70% of most of the deposits, with clay varying from about 10 to 20%. All the available analyses are shown below. In most cases the

texture of the deposits is such that working would be difficult. Silts of a structure similar to that shown by many of the deposits often occur in clay *bheels*, but these are made friable by a high content of organic matter, amounting to about 20% or more.

The average chemical constitution of the silt samples is as follows :—

Nitrogen	0.15 %
Available potash	0.015 %
,, phosphoric acid ...	0.045 %
,, lime	0.130 %
Acidity (Hopkins) ...	7
pH value of soil solution ...	6.0
pH value of Hopkins extract ...	6.0

Individual deposits show, in some cases, a wide variation from these values. Thus at Lallacherra and part of Vernerpore flooded from the Lalla stream, the acidities are much higher than denoted above. At Kukicherra and places where much of the deposit appears to have been in the nature of soils removed short distances *in situ* after local land slides, the acidities are similar to those of normal tea soils.

None of the deposits are of any particular value as fertilizers, for the nitrogen, potash and phosphoric acid content is no greater than that of an ordinary soil. Apart from this, the acidity is in most cases too low and the lime is higher than is usually found on good tea soils. These last two factors make it probable that the effect of the deposit will be detrimental to tea and are against the sucessful replanting of deeply silted areas.

Where an area has been flooded but not silted, examination shows that the acidity of such areas is still satisfactory so far as tea is concerned.

Treatment after flooding.

A summary of the treatment which should be given to tea areas after flooding may now be made. The suggestions are based largely on the

experience of planters who have dealt with flooded tea:

1. Clean out drains as soon as possible.

2. Give a light hoe to aerate the soil as soon as it gets reasonably dry.

3. Pluck very lightly after the bushes flush again.

4. Do not prune the bush until the following cold weather, when the dead wood can easily be seen. Then dead wood should be cut to live wood which means that the pruning will be at different heights on different branches. The year after, the pruning should be level again.

5. Remove dead bushes.

6. Give a stimulating manure mixture the following spring. For example :—

Sulphate of ammonia	2 cwts.	per acre.
Superphosphate	1 cwt.	
Muriate of potash	½ ,,	

Over large areas, flooding and silting were followed by the death of the tea bushes. Many dead specimens sent to Tocklai showed the presence of violet root rot (*Sphaerostilbe repens*). The question of replanting these areas is one on which we have no experience. Replanting must in any case be preceded by the removal of dead bushes. On deeply silted areas this is usually out of the question and, quite apart from this, the replanting of such places is likely to be followed by failure on account of the chemical nature of the soil.

The analyses of deposits

Below are shown analyses of silt deposits collected from Hailakandi and Chatla Bheel. For convenience the figures are given in four tables, the first including deposits from Sultanicherra, Kukicherra, Manipur and Dholai. The values indicate

percentages calculated on the dry soil and the soil fractions are given to the nearest whole figure.

Sample	Coarse sand	Fine sand	Silt	Fine silt	Clay	Loss on ignition	Nitrogen
Sultanicherra No. 1 ...	1	79	10	6	1	2·33	...
,, ,, 2 ...	*nil*	1	26	48	18	6·25	0·135
,, ,, 3 ...	1	2	30	41	18	7·02	...
Kukicherra No. 1 ...	2	59	15	15	5	4·52	0·158
,, ,, 2 ...	*nil*	1	20	49	19	7·39	0·150
,, ,, 3 ...	1	8	40	28	13	7·58	0·141
,, ,, 4 ...	*nil*	*nil*	13	58	20	7·73	0·158
,, ,, 5 ...	1	1	23	46	16	7·86	0·158
,, ,, 6 ...	1	3	14	55	20	7·75	0·146
Manipur ,, 1 ...	1	28	21	25	18	4·13	0·092
,, original soil ...	*nil*	4	22	45	20	6 50	0 097
,, No. 2 ...	1	35	32	20	7	3·77	...
,, ,, 3 ...	*nil*	73	15	7	1	2·22	...
Dholai ,, 1 ...	1	14	34	31	12	3·69	0·134
,, ,, 2 ...	*nil*	19	35	32	7	4·84	0·081
,, ,, 3 ...	*nil*	2	30	42	83	3·65	9·137

The Sultanicherra sample No. 1 is a deposit from near the river bank, showing the coarse particles deposited when the flood received its first check. The other samples are typical deposits from Jamira, with acidities of 7, *i.e.*, they are practically neutral.

The first Kukicherra sample is from No. 2 Jalnacherra, the second from No. 6, Baghara, the third from No. 5, Lambathal, the fourth from No. 3, Baruncherra, the fifth from Jalnacherra flat, and the sixth from Pingthal. All these samples show normal acidities of about 500, with the exception of No. 5, Lambathal, which shows a value of 1,438. These deposits did not come from the Khatakhal but represent the finer fractions from water-sorted local soils carried for short distances and then deposited.

The first two Manipur samples were taken from Bustithal, the former being the recent deposit and the other the original soil below the deposit. It will be observed that the deposit is lighter than the original soil which was probably laid down by slower moving water than that of the recent flood. The nitrogen content is about the same in both cases, but the acidity of the original soil is 355 against 7 in the deposit. The No. 2 sample

represents the deposit from the south end of the garden, whilst No. 3 is from the same end, nearer the river bank. Both deposits the practically neutral in reaction.

The Dholai No. 1 sample was taken from a 12 inch deposit at Kaffibari, No. 2 sample from a 4 inch deposit at Limbuguri, and No. 3 sample from No. 13 section where another 4 inch deposit was laid own. The reaction of all three samples is practically neutral.

Several soil samples from areas of Kukicherra and Dholai, which were flooded but not overlain with silt, were examined for acidity. The values are normal, showing that the flood water alone did not render the soil unsuitable for tea.

The second table shows the mechanical analyses and nitrogen values of deposits collected from gardens between Rupacherra and Barni Braes.

The samples in this table are, on the whole, much heavier than those shown in the first table, due to the fact that the coarser particles had largely been deposited at the south end of the valley.

Sample	Coarse sand	Fine sand	Silt	Fine silt	Clay	Loss on ignition	Nitrogen
Rupacherra No. 1 ...	*nil.*	4	32	37	19	7·15	0·171
,, No. 2 ...	,,	1	30	41	20	6·37	...
,, No. 3 ...	,,	5	40	32	14	6·98	...
Venerpore No. 1 ...	*nil.*	*nil.*	3	62	40	7·48	0·162
,, No. 2 ...	,,	2	23	49	18	6·23	0·148
Lallacherra ...	,,	5	9	47	26	11·41	0·276
Lallamookh No. 1 ...	,,	27	32	25	9	4·96	0·088
,, No. 2 ...	,,	87	6	3	2	1·51	...
Jafferband No. 1 ...	1	2	8	67	17	5 36	0·125
,, No. 2 ...	*nil.*	1	18	59	16	5·21	0·099
Kallacherra ...	1	3	7	56	23	8·91	0·202
Barni Braes ...	1	6	4	59	22	6·38	...

The first Rupacherra sample was taken from a 6 inch and the second from a 12 inch deposit, both on Roy flat. They are similar in texture and almost neutral. The available phosphoric acid, potash and lime in the second sample is 0.045% 0.016% and 0.154% respectively.

The Vernerpore samples are of interest in that the first is a deep deposit from the Lalla river and the second from the Khatakhal. In addition to the Lalla river deposit's showing a stiffer texture than that from the Khatakhal it also differs in acidity, giving a value of 91 against neutrality in the Khatakhal deposit.

The deposit in the Lallacherra garden was less than an inch thick, coming from the Lalla river. It is similar in texture to the No. 1 sample at Vernerpore. The acidity of the deposit is 181 and the nitrogen value very high. This is one of the few flood deposits in Hailakandi which are of value to tea.

The Lallamukh samples were not taken from the garden, on which no deposit was made, but from the Khatakhal bank near the factory. The first sample is the recent deposit, whilst the second is the original bank, below the deposit.

The Jafferband sample is a typical half-inch deposit, having a faint acidity. The second sample is a deep deposit on No. 6, flat, showing a neutral reaction.

The Kalacherra sample is from Go-bil, showing an acidity of 73, available phosphoric acid of 0.0451%, available potash of 0.017%, and available lime of 0.137%. Apart from the last value, which is too high, the others are favourable to tea growth.

The Barni Braes sample shows a physical resemblance to that of Kalacherra.

The third table deals with deposits from Aenakhal and Kunchenpore.

Sample	Coarse sand	Fine sand	Silt	Fine silt	Clay	Loss on ignition	Nitrogen
Aenakhal No. 1 ...	6	5	8	43	26	9·14	0·202
,, No. 2 ...	13	2	9	42	25	7·79	0·186
,, No. 3 ...	88	7	1	3	1	0·72	...
Kunchenepore No. 1 ...	1	9	24	33	25	7·12	0·174
,, No. 2 ...	2	1	13	43	32	9·03	0·238
,, No. 3 ...	1	6	9	41	33	8·16	0·206

The Aenakhal samples were collected near the spot where the embankment gave away. The first sample represents the original *bheel* type of soil which was flooded by slow moving water, away from the main flood. The acidity of this sample is 3,306, a normal value for soils of this type. The second sample was taken from beneath the sandy deposit indicated by No. 3 sample. This soil submitted to the main flood and some of the original soil was evidently carried away as is shown by the lower loss on ignition, lower nitrogen value and the acidity which is reduced to 1,581. The removal of some of the finer fractions would account for all these changes. The third analysis is that of the sand overlying sample No. 2 and which, before the flood, constituted the earth work of the embankment.

Of the Kunchenpore samples, the first was deposited on section No. 19, from still water. The other samples were deposited from running water and, curiously enough, show mechanical values similar to the first deposit. The acidity of these deposits is very low.

Several samples from areas at Kunchenpore, not silted up but only flooded, show normal acidities.

The last table shows the analyses of deposits collected in the Chatla Bheel district. The only thick deposits were made at Monierkhal whilst all the others are very thin.

Sample	Coarse sand	Fine sand	Silt	Fine silt	Clay	Loss on ignition	Nitrogen
Monierkhal ...	*nil*	3	34	38	17	6 88	0·121
Chingoor ...	*nil.*	*nil*	23	49	20	7·46	...
Bhubandhar No. 1 ...	1	3	8	45	23	15·54	0·158
,, No. 2 ...	1	1	3	65	21	7 85	...
Rukni	*nil.*	*nil.*	4	65	23	8·29	0·178
Rosekandi ...	3	3	1	43	40	9·89	...
Jurokhai ...	3	1	7	57	22	7·11	0·129
Silcoorie ...	1	2	3	53	30	7·76	0·139
Katal	1	1	4	64	21	7 13	0·134

The Monierkhal sample is practically neutral and shows an available lime value of 0.137%.

The Bhubandhar sample is a rich deposit, but almost neutral and high in available lime, *viz.*, 0.141%.

The Rosekandi sample was gathered from the polo ground where a deposit several inches deep was made. Several soils from various parts of this garden, flooded but not silted, were analysed for acidity and still showed normal values in this respect.

The Chingoor sample is a typical silt deposit made on the garden.

The Rukni sample is a thin deposit from Princes flat and is extremely heavy, but shows a normal acidity in spite of the fact that the available lime is high, *viz.*, 0.152%. The available phosphoric acid is 0.012%, and the available potash 0.003%.

The Borokhai sample was taken from a thin deposit on a flat. The acidity is low, 29, and available lime high, *viz.*, 0.165 %. The available phosphoric acid is 0.020%, a value above the average for tea soils in North East India.

The Silcoorie sample was also a thin deposit which shows an acidity of 402 but a high available lime content of 0.139 %, a rare combination. The available potash is 0.002% and the phosphoric acid 0.038%, the former value being low and the latter high.

The Katal sample was taken from a flat near that Ghagra river, below the bungalow. The acidity is low and the available lime 0.122%. The available phosphoric acid is 0.020%, a high value.

Soils from gardens North of the Barak and in other valleys which were flooded but not silted, have been examined for acidity. This value is in all cases normal.

NOTE

RESTORING JUTE BAGS USED FOR SUPERPHOSPHATE

(Reprinted from *The Journal of the Society of the Chemical Industry*, Vol. 49, No. 1, January 3, 1930.)

In evidence given recently before the Australian Commonwealth Tariff Board, it was stated that the wastage due to inability to use jute superphosphate bags more than once amounted in value to some £500,000 a year. Tests have indicated that, on exposure to the sun, bags containing superphosphate rapidly lose colour, whilst the fibre becomes weak and decays; but an effective remedy consists in shaking the bags free from superphosphate dust, then immersing them in a weak alkaline bath (50 gal. water containing 10 lb. soda crystals or 4 lb. soda ash suffices for 50 bags). Bags treated in this way are fit for use again, and practically immune from acidic decay.

CURVE NO. V– MANURE ADDED – JULY 27TH.

Unmanured.

Manured on 27th. July.

Lbs. of Green Leaf

100

80

60

40

20

0

Manure applied.

Pts. of Ammonia per million pts. of Soil

10

0

Pts. of Nitrate per million pts of Soil.

20

10

0

1 8 15 22 29 6 13 20 27 4 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 31 7 14 21 28 5 12 18 25 2

April May June July August September October November

CURVE NO IV.— MANURE ADDED JUNE 17TH.

Unmanured.

Manured on 17th. June.

Lbs. of Green Leaf.

100

80

60

40

20

0

Manure applied.

Pts. of Ammonia per million pts. of Soil.

10

0

Pts. of Nitrate per million pts. of Soil.

20

10

0

1 8 15 22 29 6 13 20 27 4 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 31 7 14 21 28 5 12 18 25

April. May. June. July. August. September. October. November.

CURVE NO. III MANURE ADDED MAY 6TH.

Unmanured.

Manured on 6th. May.

Lbs. of Green Leaf

100

80

60

40

20

0

Manure applied.

Pts. of Ammonia per million pts. of Soil.

10

0

Pts. of Nitrate per million pts of Soil.

20

10

0

1 8 15 22 29 6 13 22 27 4 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 31 7 14 21 28 5 12 18 25 2

April May June July August September October November

CURVE NO. II - MANURE ADDED MARCH 27TH.

Unmanured

Manured on 27th March

Lbs. of Green Leaf

100

80

60

40

20

0

Manure applied.

Pts of Ammonia per million pts. of Soil.

10

0

Pts. of Nitrate per million pts of Soil.

20

10

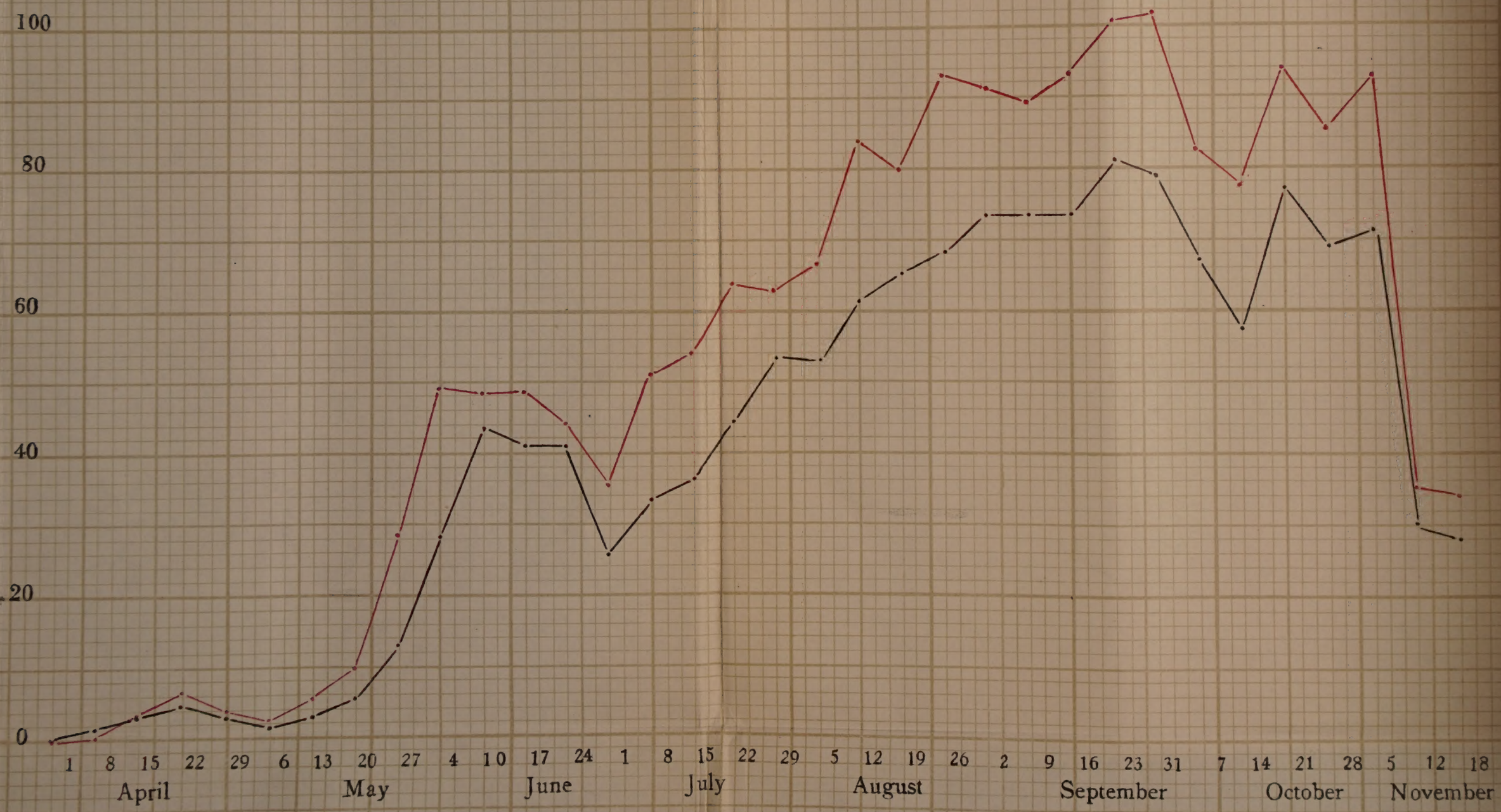
0

1 8 15 22 29 6 13 20 27 4 10 17 24 1 8 15 21 29 5 12 19 26 2 9 16 23 31 7 14 21 28 5 12 18 25

April May June July August September October November

CURVE NO I – MANURE ADDED FEBRUARY 15TH.

Unmanured.

Manured on 15th. February.

Lbs. of Green Leaf.